



Modeling Architecture for Technology, Research and

EXperimentation



**MATREX Overview Brief**  
**Presented at I/ITSEC Conference**  
**1 - 5 December 2008**



# BLUF: MATREX Brings Value to Army M&S Capabilities



- **Provides:**

- Common integrating SoS Architecture to synchronize M&S across RDECOM Labs & Centers
- A path for testing and distributing M&S R&D in the M&S Community
- Collaboration with external M&S communities (TRADOC, ATEC, FCS, JFCOM, etc.)
- Common Core Simulation Infrastructure and Tools
- Common Systems Engineering Processes for M&S
- Distributed / Collaborative enabling services:
  - Web Collaboration (IDE & STEM)
  - Distributed Virtual Lab Services

- **Supports PEOs & PMs with a coordinated & collaborative RDECOM-wide M&S approach**

- **Maximizes interoperability, flexibility & adaptation of RDECOM M&S capabilities to Acquisition Community needs**

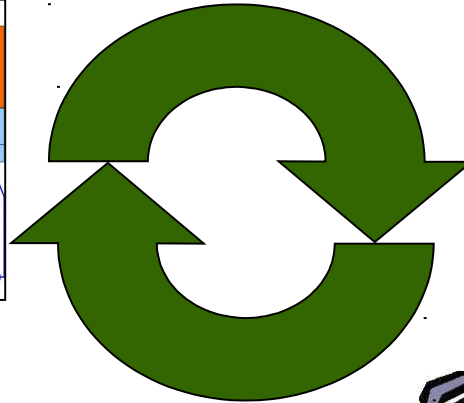
***MATREX expands RDECOM capabilities to support the Army's mission with M&S***



# MATREX Overview

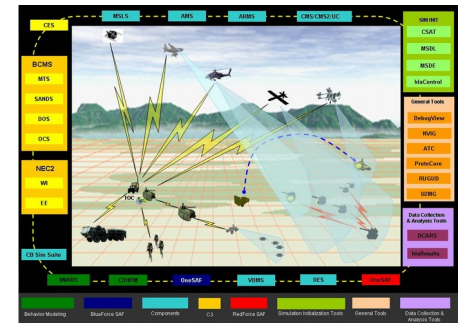
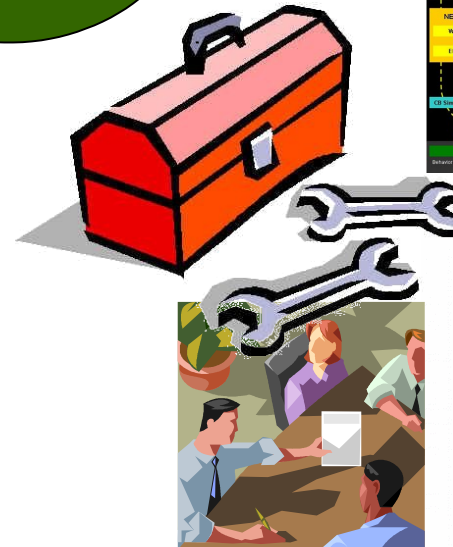


**M&S R&D Made Real**  
*Community use informs*  
**R&D**



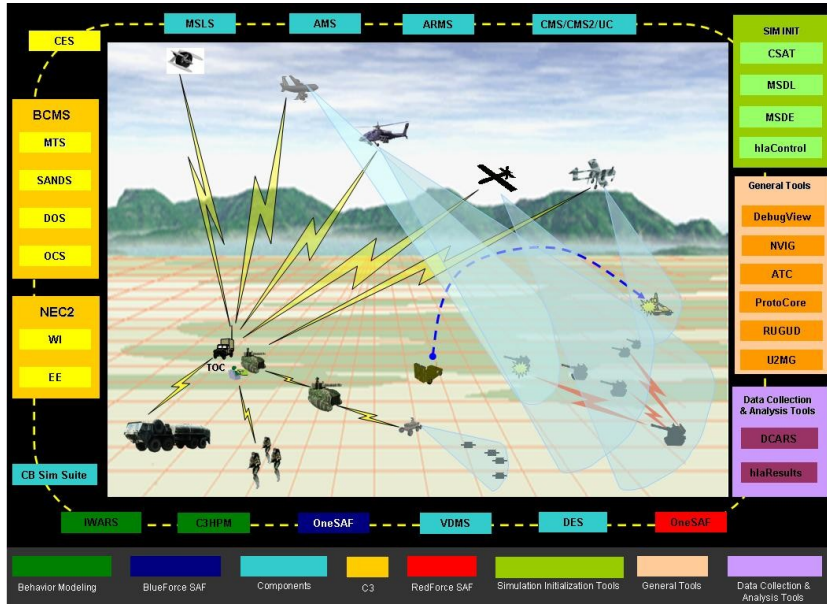
## Primary Elements of MATREX

- Architecture / Environment
- Model & Simulations
- Tools
- Interoperability
- Collaboration





# MATREX Purpose



## Purpose:

To develop a composable M&S environment wherein a collection of multi-fidelity models, simulations and tools can be integrated, and mapped to an established architecture for conducting analysis, experimentation and technology trade-offs for RDECOM and others.

## Benefits:

- Enables reconfiguration and reuse of components for:
  - Engineering model development and evaluation
  - Technology tradeoffs
  - Capabilities assessments
  - Concept development
  - Experimentation
  - Testing
- Mutually and collectively leverages the world-class expertise of all RDECOM M&S laboratories for the benefit of the Army as well as Joint services

## Primary Partners and Customers:

- RDECOM HQ, RDECs, and Labs
- PM FCS (BCT) MSO / FCS LSI
- TRADOC (BLCSE)
- ATEC (OTC)
- 3CE (Cross Command Collaboration Effort)
- Other Army PMs and PEOs

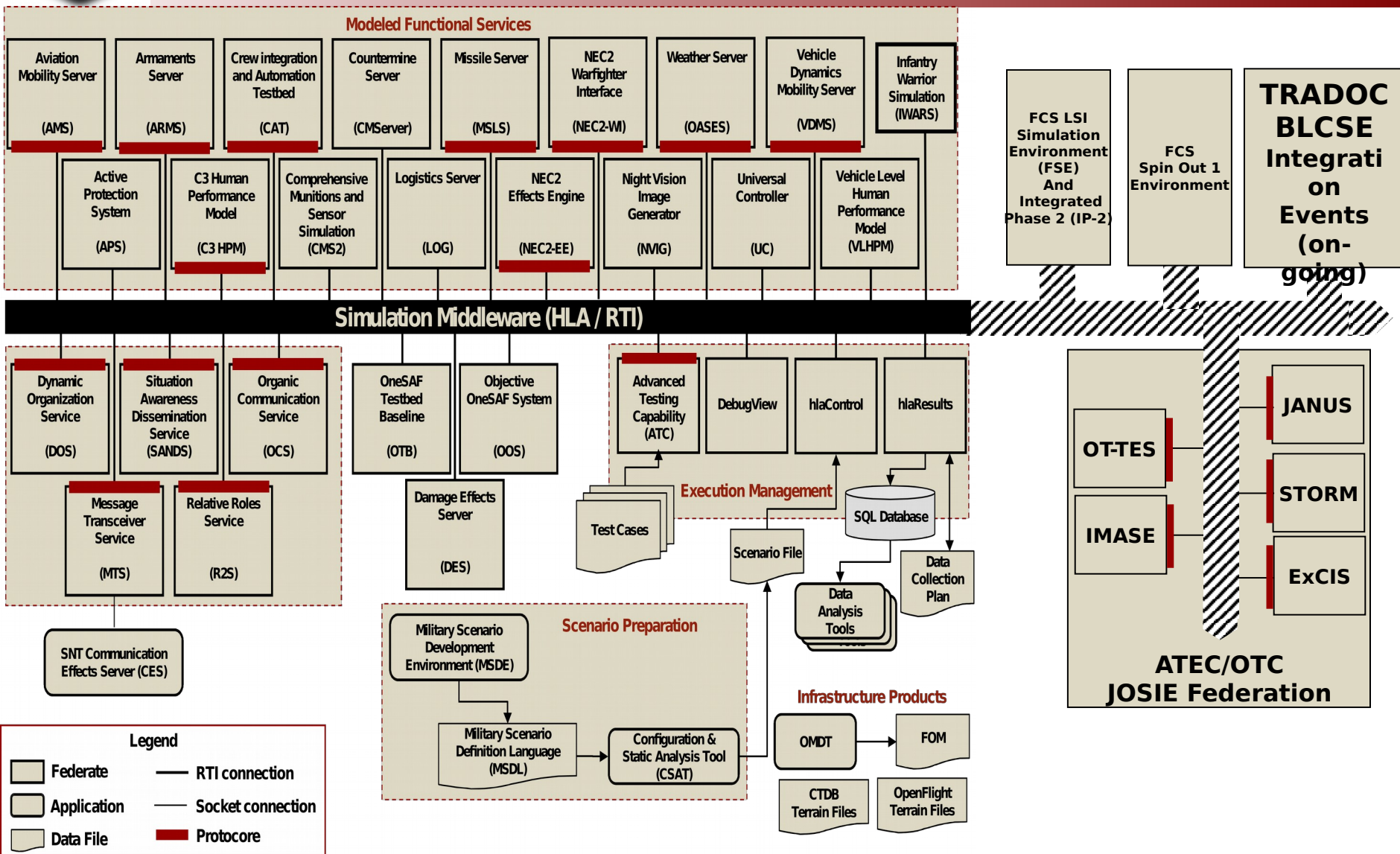
**Critical M&S capabilities necessary to support the Network Centric Warfare representation and analysis**







# MATREX Building Common Cross-Army Environment



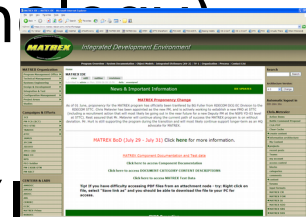
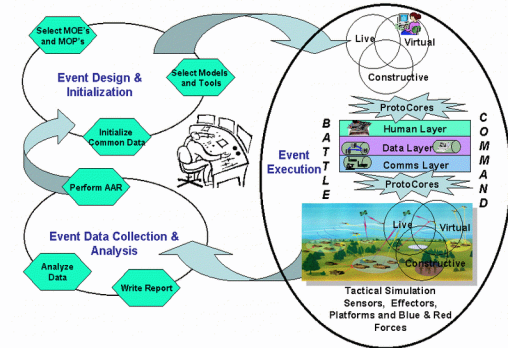
**MATREX Provides Many Integrated Capabilities**



# MATREX Project Areas



- M&S Tools – Usable S&T
- Event Management
- OneSAF Transition
- Human-Centric Enabled Battle Command (HC-NEBC)
- Networked Effects Command & Control (NECC)
- MATREX Middleware Independence Capability (MMIC) (Protocore is the enabling technology)
- Distributed Virtual Laboratory (DVL)
- Integrated Development Environment (IDE)
- Verification, Validation, & Accreditation





# MATREX Tools Enable a Common Integrated Architecture



**Lowers the barrier to entry for utilization of MATREX High-Level Architecture (HLA) and widely used ATEC, RDECOM, and TRADOC M&S and tools**

## **Federation Object Model (FOM)**

1. In-common data structures, operations, and communication between federates
2. Describes which HLA services are used, how they are used, & how they are tied to events
3. Co-managed with FCS LSI, providing basis for commonality in FCS M&S community, RDECOM, TRADOC, ATEC, etc.

## **ProtoCore**

1. M&S interoperability without gateways
2. Provided as GFX by MATREX with support & training available
3. Interoperability includes HLA RTI 1.3NGmatrex, IEEE 1516, & TENA 5.4 (DIS in FY09)

## **Battle Command Management Services (BCMS)**

1. Supports entity-level communications and SA dissemination for Battle Command
2. Interconnects comms effects, sensor fusion, human behavior, network, human decision-making, OneSAF, & High-Fidelity M&S
3. Components include MTS, OCS, DOS, SANDS, & R2S

## **Configuration and System Administration Tool (CSAT)**

1. With OneSAF MSDE, complete scenario development process & tool set to improve Simulation Initialization capabilities as part of MATREX Event Management effort
2. Helps with remote creation of federates and force structure lay-down.
3. Provided as GFX by MATREX with support & training available for both MSDE and CSAT

## **Run-Time Infrastructure (RTI)**

1. Enables M&S interoperation over a network, including distributed
2. Embedded functionally to support entity-level analysis
3. Provided as GFX by MATREX, supported by MATREX

## **Distributed Virtual Lab (DVL) network**

1. Securely interconnects RDECOM M&S users/developers via DREN
2. Connected to ATEC, TRADOC, and FCS LSI
3. Maintained by MATREX and the Centers/Labs

## **Integrated Development Environment (IDE)**

1. MATREX distributed engineering and communication capability over Internet
2. Linked and mapped content mgt system for requirements, design, coding, & execution
3. Program Configuration Management mechanism

## **Advanced Test Capability (ATC)**

1. Unit, integration, and federation-level testing of M&S applications
2. Automated test case development, mapped to requirements
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5. Enables executable architecture





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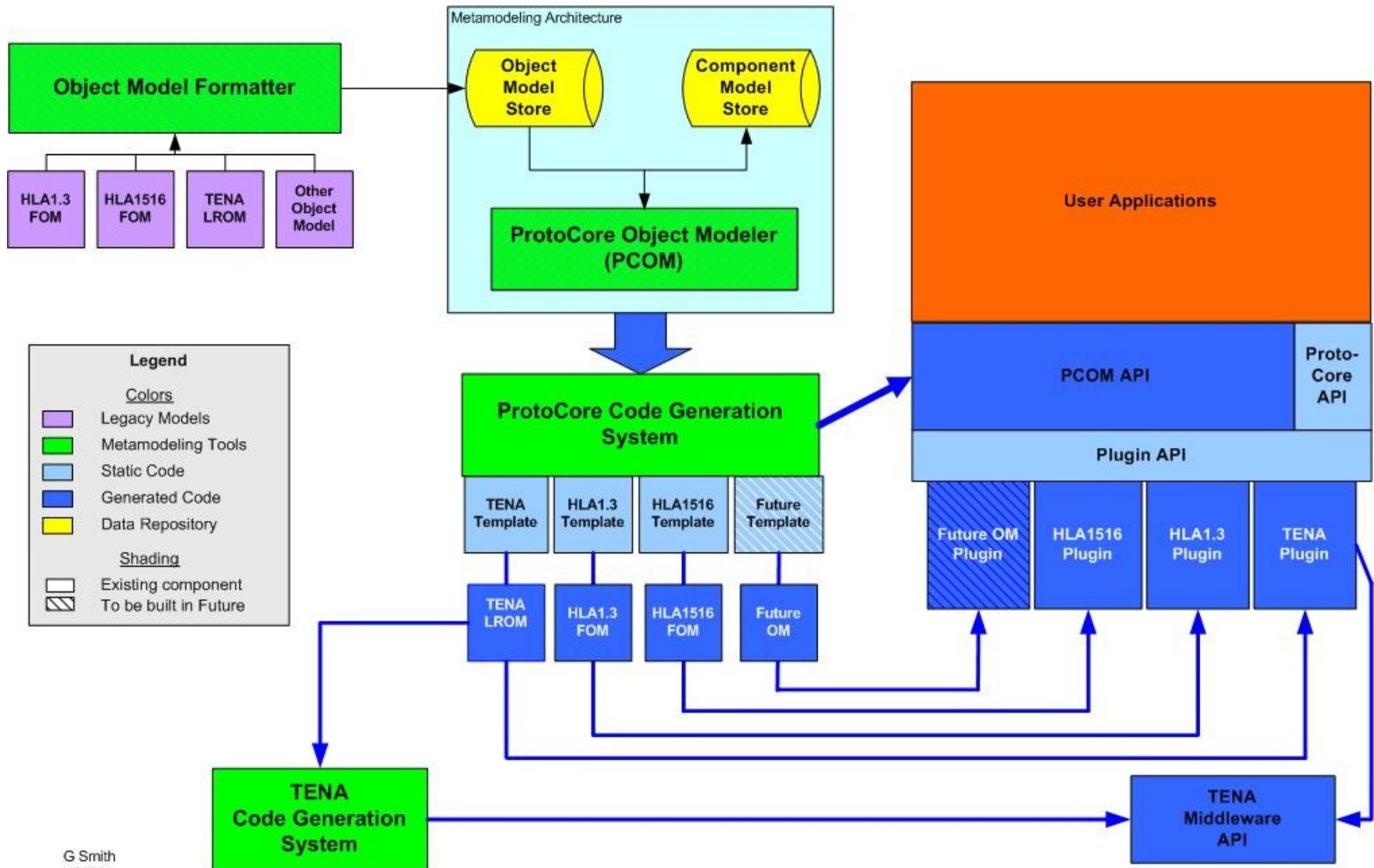
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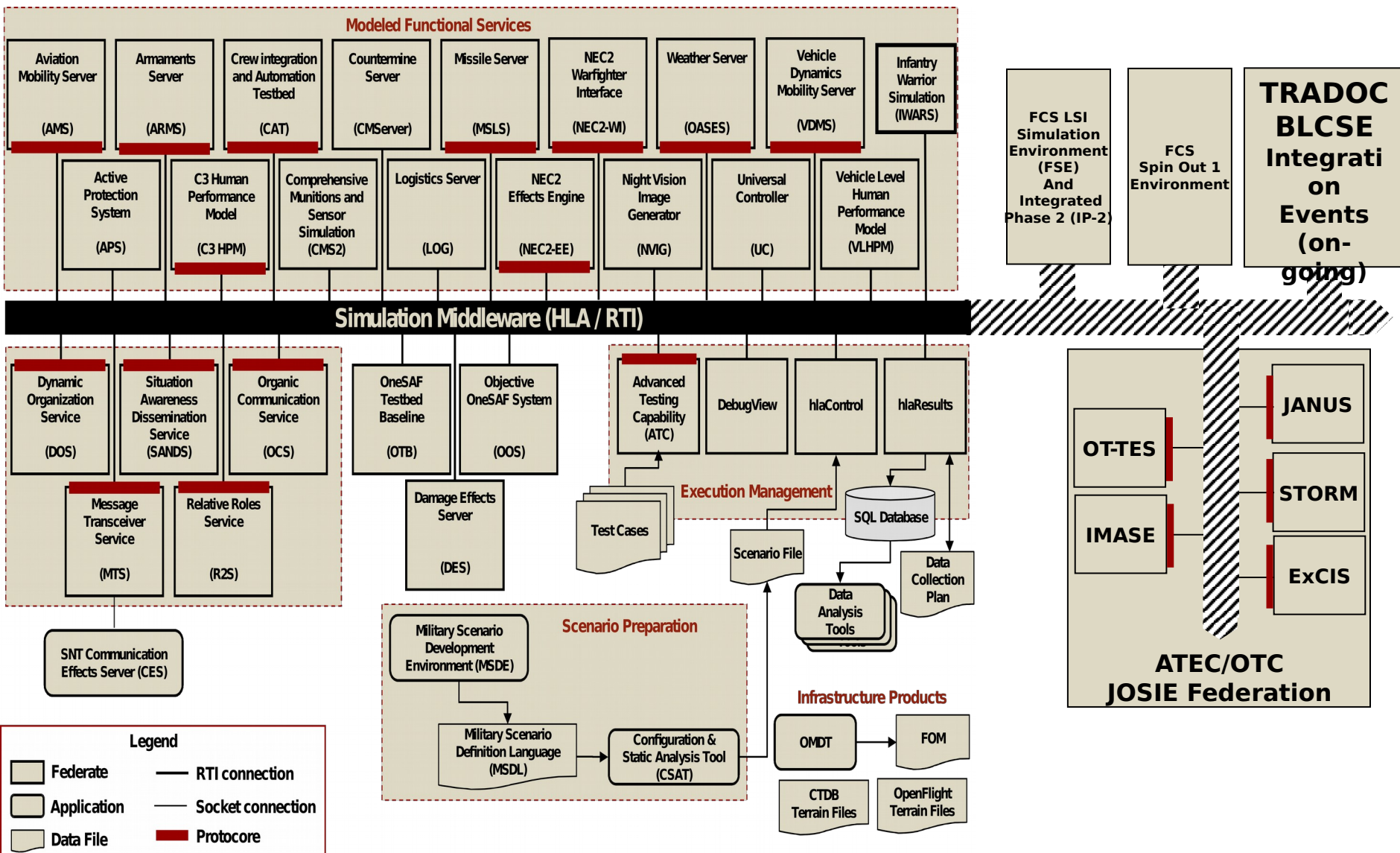
# MATREX Middleware Independence Capability (MMIC) ProtoCore - Object Model Architecture



G Smith  
2008



# MATREX Building Common Cross-Army Environment





# 2008 Awards



## DoD M&S Award for Test & Eval.

- *MATREX Partnered with ATEC OTC to assist them in their transition of the OASIS JOSIE components to HLA via the MATREX Protocore*
- *By using ProtoCore, gained 2 types of HLA (1516 & 1.3NG) & also TENA*



## Army M&S Award for Test & Eval.

**EC cost avoidance of approximately \$2M and 18 months budget**





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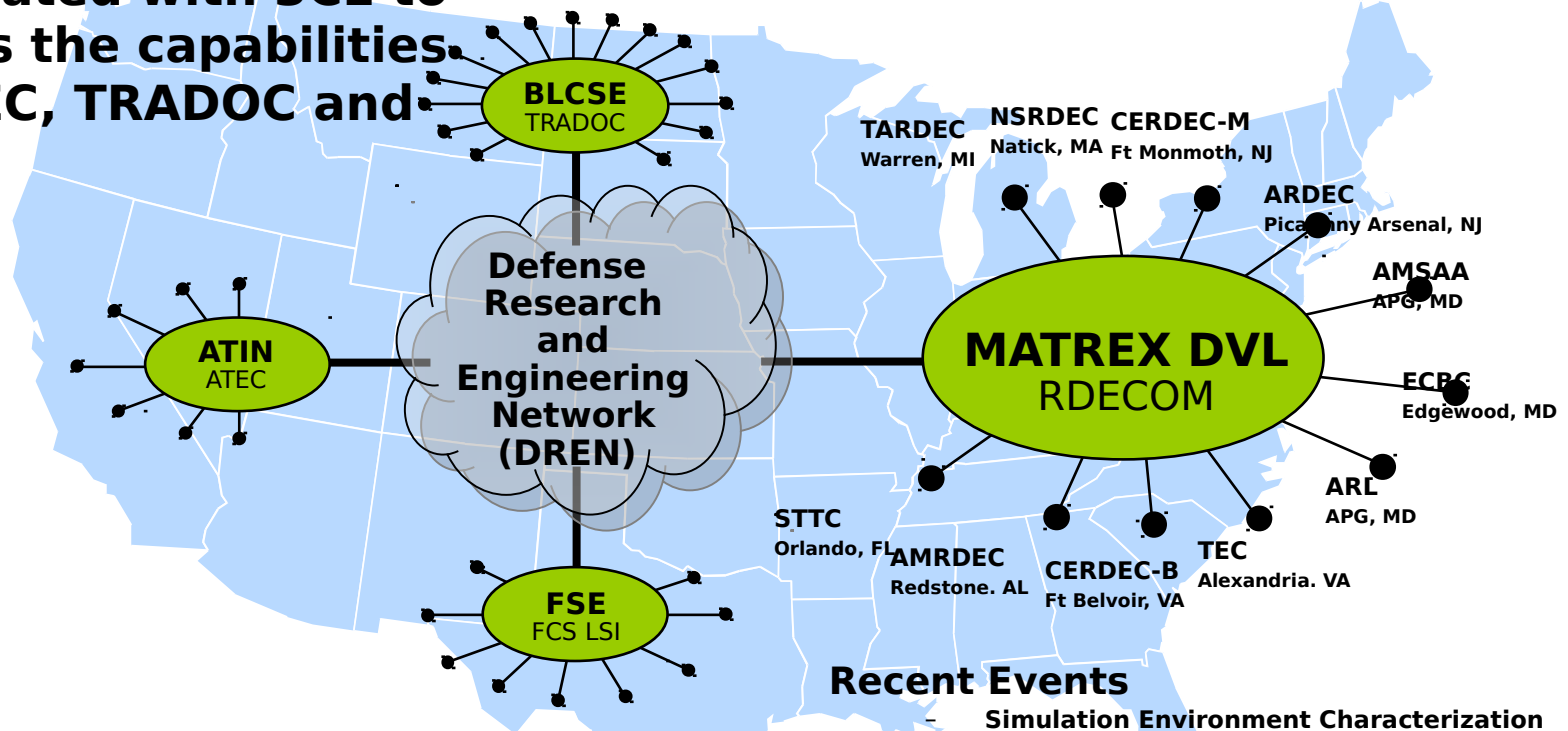
# Distributed Virtual Laboratory (DVL)



To Be Connected

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**Integrated with 3CE to  
access the capabilities  
of ATEC, TRADOC and  
FCS**



- Persistent Classified network architecture via DREN
- Facilitates sharing of capabilities
- Collaborative use of RDECOM and Army resources
- Analyze requirements as integrated systems of systems

## Recent Events

- Simulation Environment Characterization Assessment (SECA) Event
- Soldier Experiment (AMRDEC, TARDEC)
- Spin Out 1 Integration Events (SO1-IEs)
- Earth, Wind and Fire (Ft. Sill, ARDEC)
- FCS ACE Service (ARL, TARDEC, ARDEC)



# MATREX IDE



## IDE is tailored to M&S Engineering architectural efforts

- Dynamic content creation, maintenance, & modifications that enable all program personnel to contribute knowledge by directly creating & modifying content (with appropriate permissions)
- Enables distributed complex software development, from requirements through Systems Engineering & design to a shared model development environment (future).

### Program Management

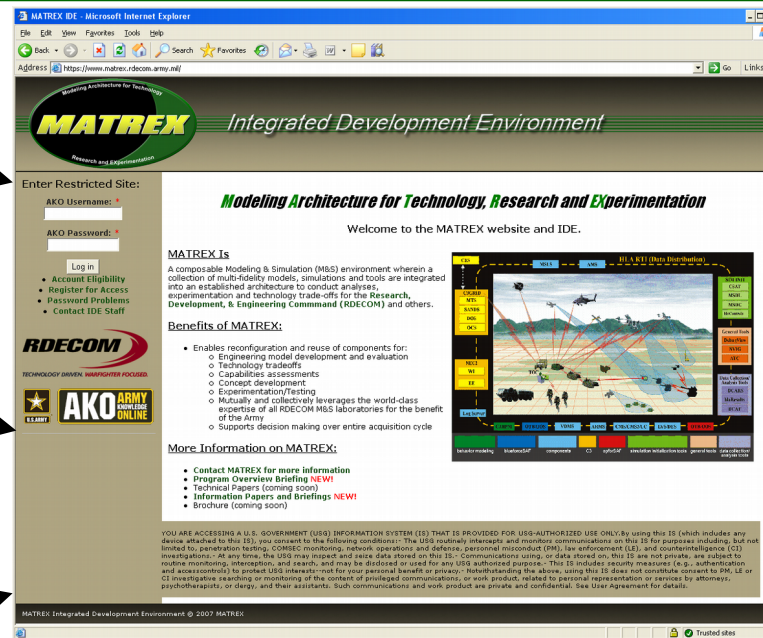
View high level status  
View and update schedule documents

### Marketing

Educate potential customers and stakeholders  
Repository for Army M&S best practices

### Operations & Support

Event management concept of operations  
Users manual  
Technical support interface



### Design and Development

View design documentation and link developer documentation  
Developer documentation creation / organizing / linking / updating

### Integration & Testing

Test cases based on system design for closed-loop product delivery

### Systems Engineering

### Systems Design

### Systems Architecture

Process management  
Requirements management  
Engineering Document management  
Training and education



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# MATREX Event Management

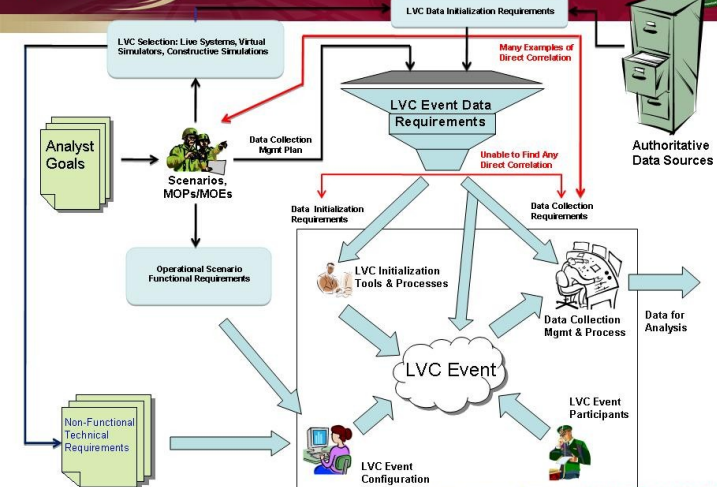
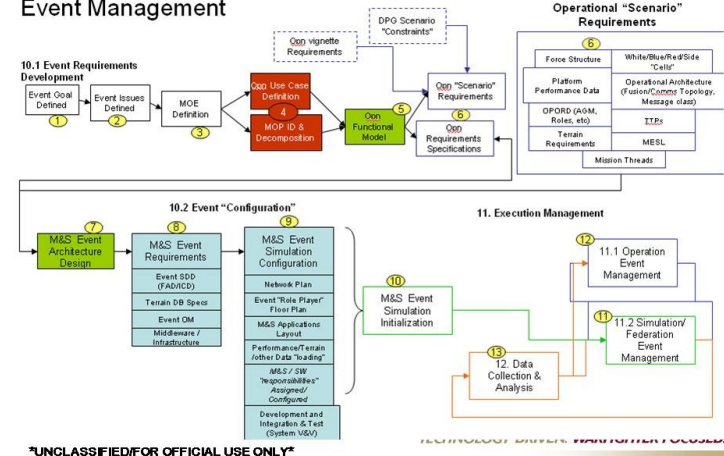


## Event Management Includes the Following (And More):

- Development of Event Requirements
- Development of Operational Scenario Requirements
- Design of M&S Event Architecture
- Development of M&S Event Requirements
- Design of M&S Event Simulation Configuration, Including Interface to Live and Virtual Elements
- Simulation to C4I Interoperability
- M&S Event Simulation Initialization
- Simulation/Federation Event Management, Within Context of Overall Event Operation/Execution Management
- Data Collection & Analysis



### Event Management

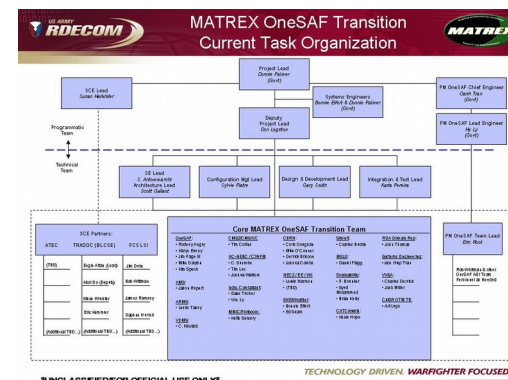
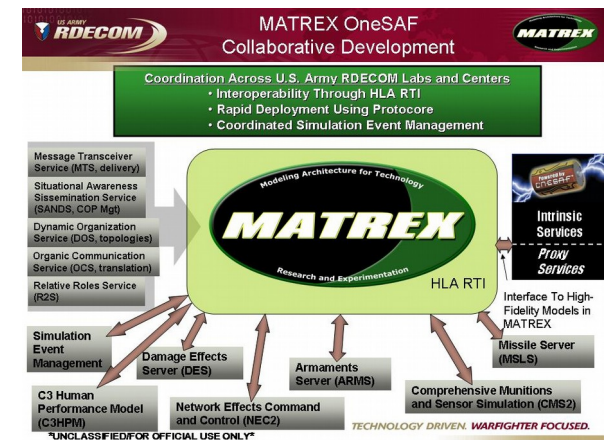




# MATREX OneSAF Transition



- MATREX is an Official OneSAF Collaborative Developer
  - FY07 focus was to “swap” OTB out & replace with OneSAF (i.e., maintain same interface functionality with MATREX components).
  - All “Swap” interface work by MATREX completed as planned & delivered to PM OneSAF in “Handover Package” & integrated into baseline.
  - Additional MATREX modifications continue to be developed & rolled-in.
- Developing Cross-RDECOM OneSAF Collaborative Development Team
  - User Training via PM OneSAF
  - Developer Training
    - PM OneSAF Provided
    - MATREX provided & subsidized

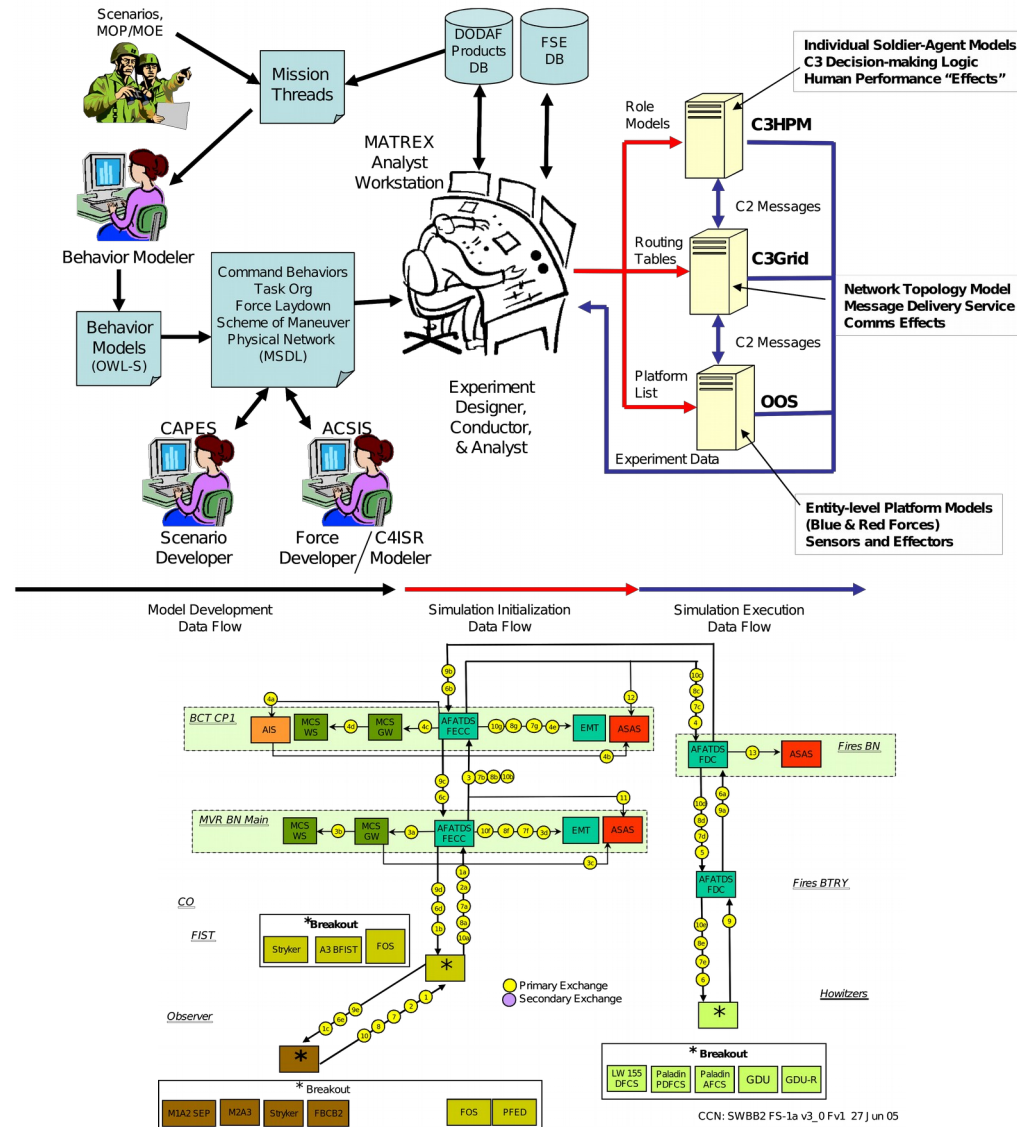




# Human-Centric Networked-Enabled Battle Command (HC-NEBC)



- **Models:**
  - Information management and C2 tasks to an individual soldier-level fidelity
  - Human decision-making
- **Provides:**
  - Human “effects” in the form of time and accuracy degradations in situational awareness and decision making
  - Reusable behavior definitions derived from Army Interoperability Certification testing mission threads
  - Analyst interfaces which support force analysis and organizational design issues





# MATREX Network Effects Command and Control (NEC2)



- Overview

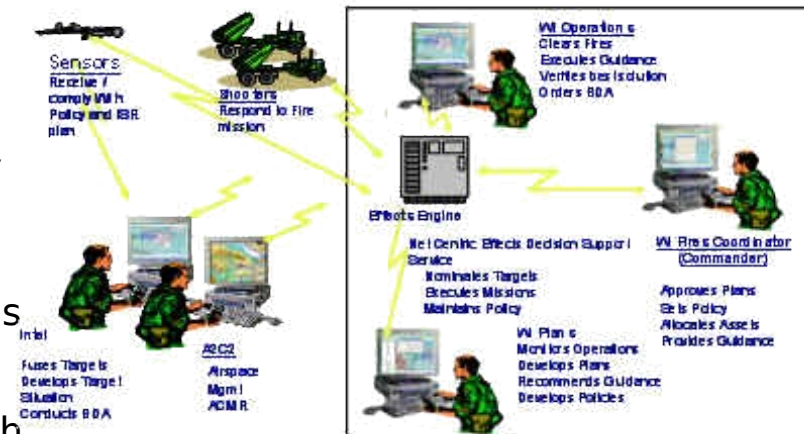
- Networked Fires component of MATREX baseline
- Enables experimentation to examine the issues of networked effects in a bandwidth constrained environment

- Implementation

- Combines features of Advanced Field Artillery Tactical Data Systems (AFATDS), two networked fires prototypes (Combat Decision Aid System (CDAS) and ProtoCommand), current Command and Control (C2) prototypes for FCS (MC2), and a communications effects server (BCMS)
- Centers around an “Effects Engine” (EE) which executes decision support and targeting processes as a network service. Performs target values analysis and attack analysis

- Managing the Network – Key to Success

- Pairs the tactical requirements of fires control with management of the message flow and network linkages throughout the network
- Network is managed by policies that are

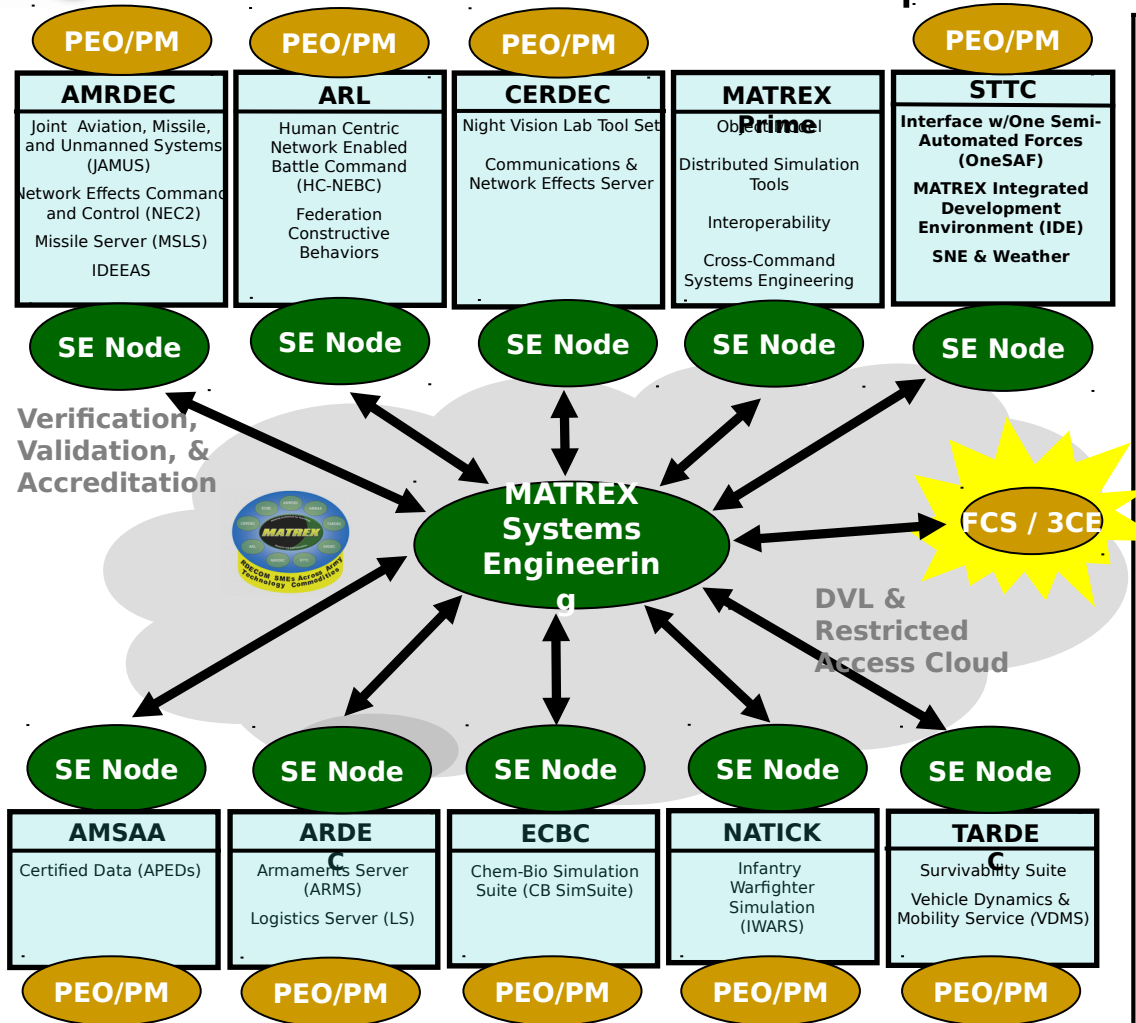


***NEC2 supports experimentation with Networked Effects. MATREX and NEC2 provide a significant toolset to conduct credible Brigade and Below experimentation with critical “tuning knobs” exposed to the war fighter in order to establish minimum network requirements and flesh out workable tactics techniques and procedures.***





# Systems Engineering for MATREX & RDECOM: Operational View



## Integrated M&S System of Systems Engineering (SE) Capability for RDECOM via MATREX:

- Supporting PEOs and PMs with a coordinated and uniform RDECOM approach
- Common integrating SoS Architecture synchronized across RDECOM
- Developing SE Nodes for M&S across RDECOM:
  - Single integrated M&S culture
  - In-Common engineering tools
  - Common requirements database, terminology, and processes
  - Distributed and Collaborative enabling services:
    - Web Collaboration (STEM, IDE, AKO)
    - DVL Services
- Maximize interoperability, flexibility and adaptation of RDECOM M&S capabilities to the Acquisition Communities needs.
- Common OM and Core Capabilities/Tools

**MATREX reduces Technical and Cost Risks in programs through coordination**



# MATREX Collaborations: RDECOM & Beyond



Some of the groups we work with:

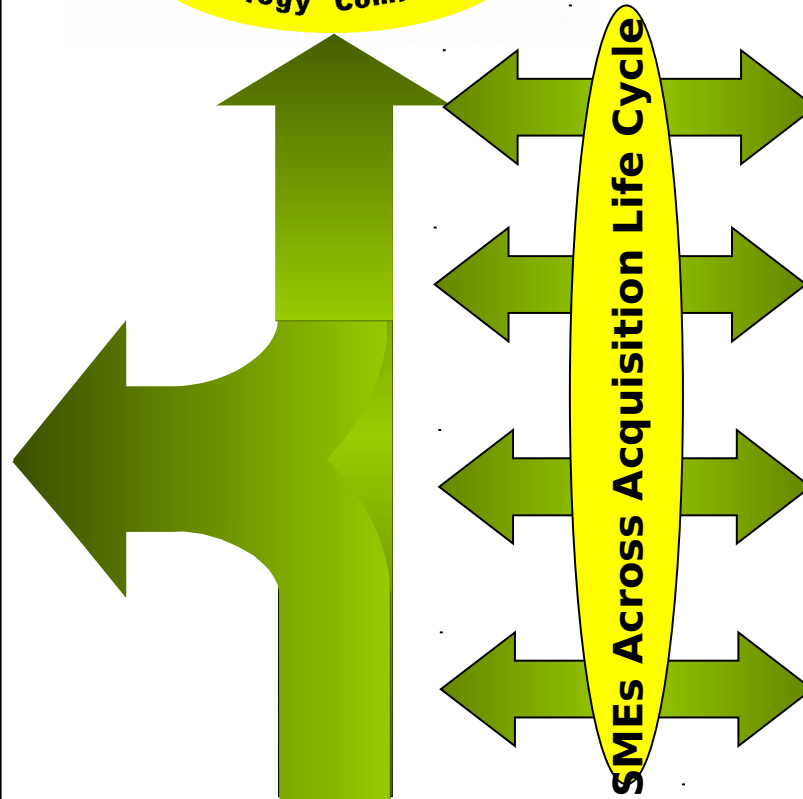
TRADOC	Mounted Maneuver Battle Lab
	Air Maneuver Battle Lab
	Depth & Simultaneous Attack B
	Battle Command Battle Lab
	TRAC Leavenworth
ATEC	TRAC-WSMR
	IRCC WSMAR
	HQ USAOTC
	USAOTC-IEW
	Electronic PG, Fort Lewis
	APG Test Center
	WDTC, Dugway PG
	RTTC
PM	RTTC-RSA
	PEO-STRI
	NLOS-LS
	PM C4ISR On-The-Move
	PM FCS (BCT) - FCS LSI
Other Services	PEO Soldier
	LMC-Orlando (USN)
	Navy Research Lab
	Naval Air Warfare Center
	JTAGSS (USAF)

Note: A full list of groups available upon request.



Fielding of  
capabilities to  
provide feedback for  
R&D direction and  
decisions

Partners & Collaboration



## ATEC (OTC/DTC)

- Test Event Support
- Live Interface
- Sim to C2
- Sim Research

## TRADOC

- Analytical Requirements
- BLCSE Conversion to HLA
- FFID Planning
- Sim Infrastructure & Tools

## 3CE

- Core Planning
- Sim Systems Engineering
- Federation/FOM/Tools
- FCS Spin Out 1
- Sim Infrastructure & Tools

## FCS LSI

- FOM
- FCS Simulation Environment (FSE)
- Collaboration & Development
- GFX Delivery, Training & Support



# Primary MATREX Campaigns



- **Future Combat Systems (PM FCS BCT MSO & FCS LSI)**
- **Cross-Command Collaboration Effort (3CE)**
- **Mounted Maneuver Battle Lab (MMBL), Ft. Knox, KY**
- **Battle Lab Collaborative Simulation Environment (BLCSE)**
- **ATEC Operational Test Command (OTC)**
- **PM Stryker Brigade Combat Team (SBCT)**
- **Joint Forces Command (JFCOM)**
- **Joint Improvised Explosive Devices Defeat Office (JIEDDO)**
- **JPEO Chemical Biological Defense (CBD)**
- **M&S Coordination Office (MSCO)**
- **Naval Postgraduate School (NPS)**
- **PEO Soldier**
- **Joint Aviation Manned & Unmanned Systems (JAMUS)**
- **PM C4ISR On The Move (OTM)**

**Event support is customer funded**



# MATREX Summary



- **MATREX exists to provide integrated RDECOM-wide M&S capabilities to help reduce technical, cost, and schedule risk**
  - Reduces duplicative M&S efforts
  - Reuses current M&S models and tools in new ways with new customers
  - Fosters collaboration - ongoing active dialogue among the labs
- **MATREX is also working with TRADOC, ATEC, PM FCS(BCT) / FCS LSI, and 3CE to build an Army solution for M&S experimentation applicable across the acquisition life cycle**
  - Ensures interoperability and composability across Army M&S capabilities
  - Enables more integrated and collaborative analysis so PMs can ensure that all parts of their R&D investment work together across the acquisition lifecycle
- **Supports M&S design, development, test, integration, and applications**
  - Core program is focused on architecture, processes and tools
  - Processes involve all elements of RDECOM
- **MATREX architecture, processes, tools and models are maturing to support NCW modeling and analysis in a distributed environment**
  - Provides unique capability to model both information & decision making

**MATREX is a tool available for *your* use**





# Acronyms



- 3CE – Cross-Command Collaborative Effort
- ACS – Aerial Common Sensor
- AKO – Army Knowledge On-Line
- ALCES – Aggregate Level Communications Effects Service
- AMS – Aviation Mobility Service
- AMSWG – (OSD) Acquisition Modeling & Simulation Working Group
- ARMS – Armaments Service
- ATC – Automated Test Capability
- ATEC – Army Test and Evaluation Command
- ATIN – ATEC Test Integration Network
- AUTL – Army Universal Task List
- BCMS – Battle Command Management System
- BCT – Brigade Combat Team
- BLCSE – Battle Lab Collaborative Simulation Environment
- C3HPM – Command, Control, & Communications Human Performance Model
- CES – Communications Effects Server
- CMS – Countermine Server
- CMS2 – Comprehensive Munitions & Sensor Server
- CSAT – Configuration and System Administration Tool
- C4ISR – Command & Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
- DCARS – Data Collection, Analysis & Reporting System
- DCA – Data Collection & Analysis
- DCAT – Data Collection & Analysis Tool
- DES – Damage Effects Server
- DOTMLPF – Doctrine, Organization, Training, Materiel, Leadership, Personnel & Facilities
- DOS – Dynamic Organization Service
- DTC – Developmental Test Command
- DTE – Distributed Test Event
- DT&E – Developmental Test and Evaluation
- DVL – Distributed Virtual Laboratory
- EE – Effects Engine
- FCS – Future Combat Systems
- FOC – Full Operational Capability
- FOM – Federation Object Model
- FRP – Full Rate Production
- FSE – FCS Simulation Environment
- HLA - RTI – High Level Architecture – Run Time Interface
- HC-NEBC – Human Centric – Network Enabled Battle Command
- HPM – Human Performance Model
- IDE – Integrated Development Environment
- IOC – Initial Operational Capability
- IOT&E – Initial Operational Test and Evaluation
- IER – Information Exchange Requirement
- IPO3 – Integrated Process 03, Networked Fires
- IPT – Integrated Process Team
- IWARS/DI – Infantry Warrior Simulation/Dismounted Infantry
- JCAS – Joint Close Air Support
- JCIDS – Joint Combat Integrated Defense System
- JROC – Joint Requirements Oversight Council
- JSBE – Joint Service Battlespace Environment
- KPP – Key Performance Parameters
- LSI – Lead Systems Integrator (FCS)
- LVC – Live Virtual Constructive
- LVCI – Live Virtual Constructive Interoperability
- LVS – Lethality/Vulnerability Service
- MATREX – Modeling Architecture for Technology, Research, & EXperimentation
- MC2 – Mobile Command & Control
- MDA – Model Driven Architecture
- MMIC – MATREX Middleware Independence Capability
- MOE – Measures of Effectiveness
- MOP – Measures of Performance
- M&S – Modeling and Simulation
- MSDE – Military Scenario Development Environment
- MSDL – Military Scenario Definition Language
- MSLS – Missile Service
- MSO – PM FCS (BCT) Modeling & Simulation Office
- MTS – Message Transceiver Service
- NCW – Network Centric Warfare
- NEC2 – Networked Effects Command & Control
- NVIG – Night Vision Image Generator
- OCS – Organic Communications Service
- OneSAF – One Semi-Automated Forces
- OOS – OneSAF Objective System
- OTB – OneSAF Testbed Baseline
- OTC – Operational Test Command
- PEO – Program Executive Office
- PM – Product, or Program or Project Manager
- R2S – Relative Roles Server
- RDECOM – Research, Development, & Engineering Command
- RDEC – Research, Development & Engineering Center
- S3E – Systems Engineering, Experimentation, and Enterprise
- SANDS – Situational Awareness Normalization & Dissemination Service
- SE – Systems Engineering
- Sim Init – Simulation Initialization
- SNE – Synthetic Natural Environment
- SoS – System of System
- SoSE – System of System Engineering
- SOSCOE – System of Systems Common Operating Environment
- STEM – Science and Technology Enterprise Management
- S&T – Science and Technology
- TENA – Test & Training Enabling Architecture
- TIE – Technical Integration Event
- TRADOC – Training & Doctrine Command
- UAV – Unmanned Aerial Vehicle
- UC – Universal Controller
- UJTL – Universal Joint Task List
- USAF – United States Air Force
- USMC – United States Marine Corps
- VDMS – Vehicle Dynamics & Mobility Service
- V&V – Verification and Validation
- VV&A – Verification, Validation & Accreditation
- WECM – Warfighter Electronic Collection and Mapping
- WI – Warfighter Interface



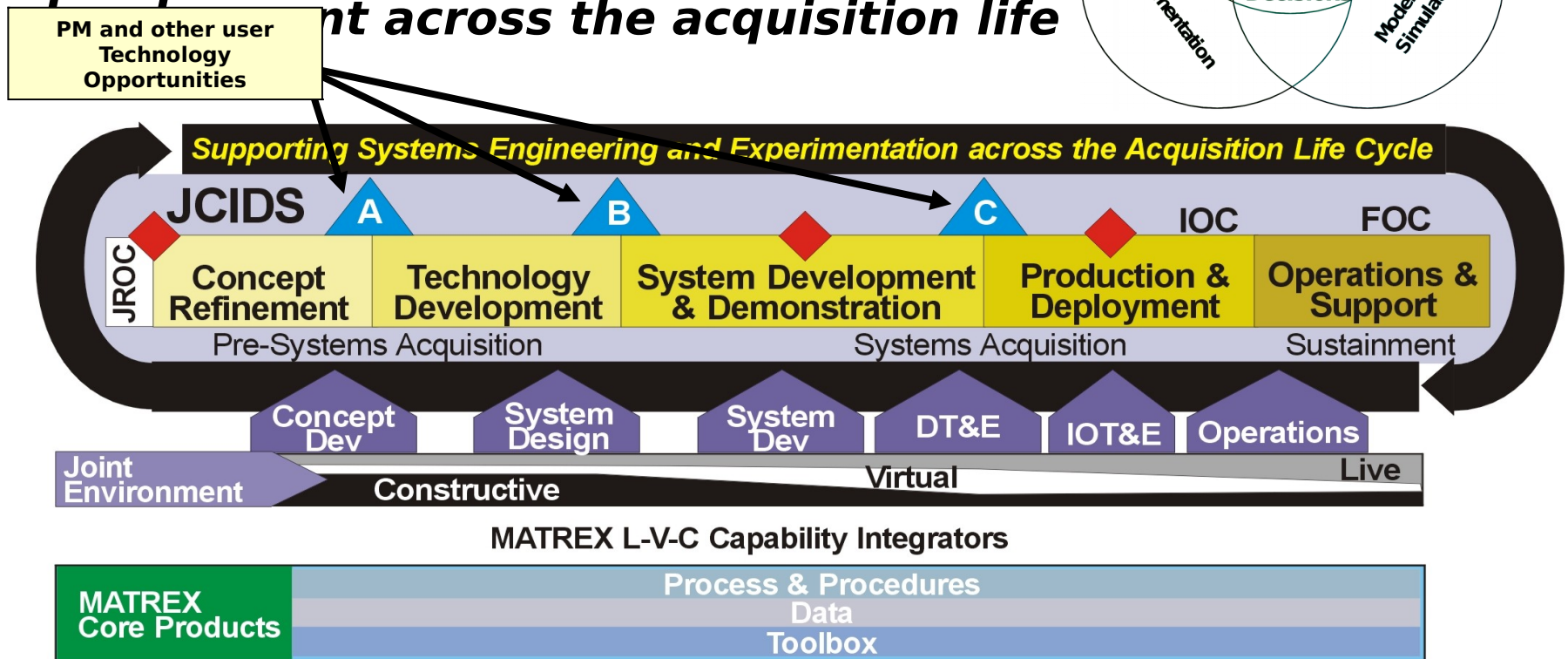
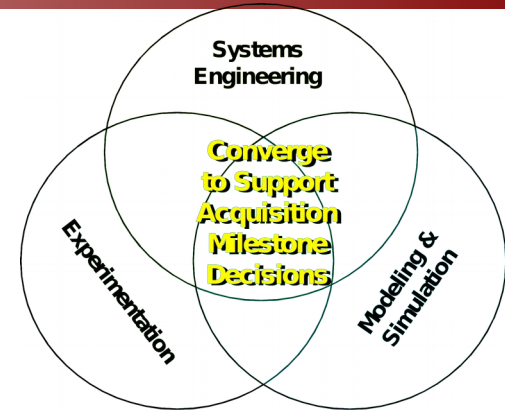
# BACK-UP SLIDES



# MATREX Supports Entire Acquisition Life Cycle



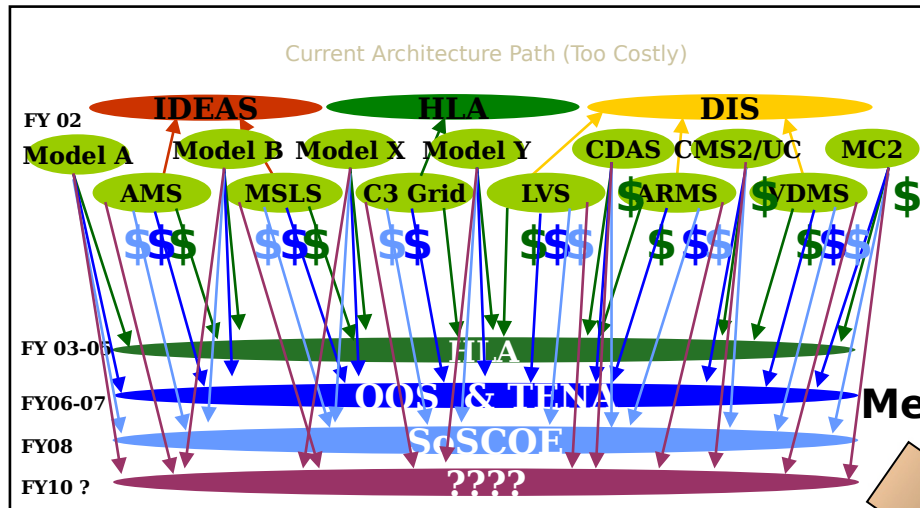
**Enable cross-commodity M&S tools, capabilities, processes and people to support technology development, systems integration and product support across the acquisition life**



**Reduce expense of "Live" activities**



# MATREX Enables M&S Seamless Interoperability

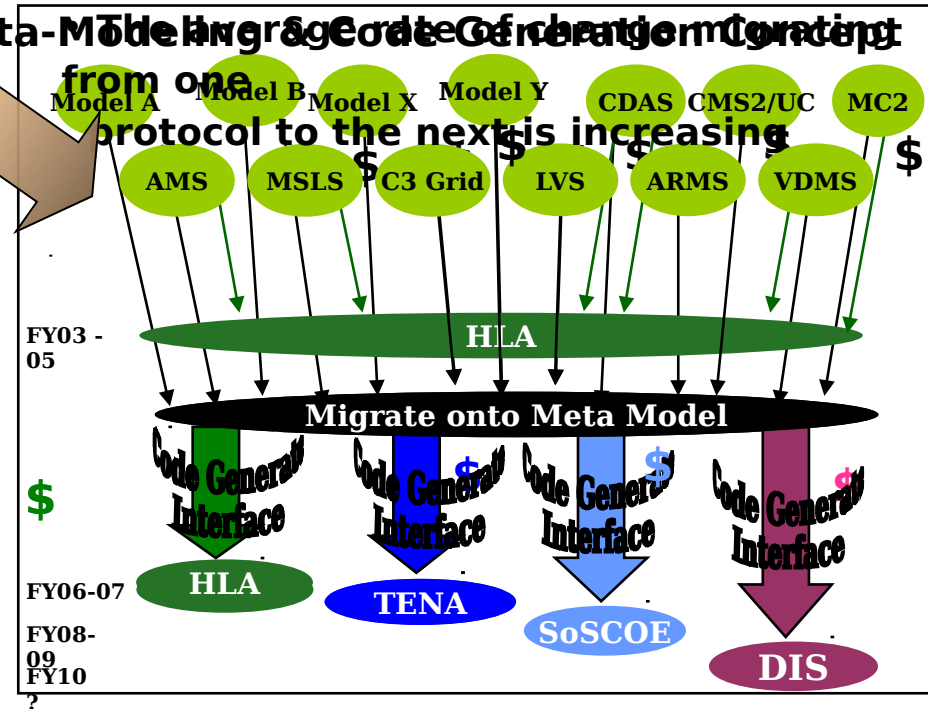


## Results

- In use at RDECOM M&S activities
- In use at OTC with JOSIE+1 federation
- In use at FCS LSI at Huntington Beach FSE
- In use at Spin Out 1 events
- Planned for Stryker and other PMs in CY 2008
- Demonstrated at 2006 and 2008 DoD M&S Conference

## M&S Interoperability Problem Space

- The Army spends millions of dollars per year migrating Models and Simulations between various protocols and building gateways







# FY08 MATREX Projects (1/2)



<b>Activity</b>	<b>Description</b>
<b>Network Centric Warfare</b>	<b>M&amp;S supporting entity-level analysis/experimentation capabilities of Battle Command</b>
<b>Distributed Virtual Laboratory (DVL)</b>	<b>RDECOM network supporting distributed simulation, simulation events, interoperability with ATEC, TRADOC, FCS LSI</b>
<b>Event Management</b>	<b>Sim Init, DCRA, Analysis, Data, SE, tools, and processes, cross-command collaborative development, 3CE Sim Init IPT lead, Data Management IPT participant</b>
<b>VV&amp;A</b>	<b>Independent assessment and update of MATREX/RDECOM M&amp;S products</b>
<b>RDECOM</b>	<b>MATREX tools, processes, integrated RDEC federates, SE processes, IPT support, DVL, integrated PEO/PM support</b>
<b>3CE</b>	<b>3CE Core Planning, collaborative requirements development, host or support IPTs, SO1 Support for HLA and MATREX FOM</b>
<b>FCS LSI</b>	<b>Integrate Armaments Server, Missile Server, MATREX HLA, FOM, tools, collaborative architecture and environment development</b>
<b>ATEC OTC</b>	<b>Transition JOSIE+1 USAOTC federation from DIS to MATREX HLA using ProtoCore, training, support, develop L-V-C interoperability</b>



# FY08 MATREX Projects (2/2)



Activity	Description
<b>TRADOC BLCSE (MMBL)</b>	<b>Supporting installation of MATREX HLA, tools (inc SA dissemination), and federates at MMBL, proof of process prior to engaging other battle labs</b>
<b>C4ISR On-The-Move Testbed</b>	<b>Phase 1: Transition to MATREX HLA and tools; Phase 2: Support MATREX community with MATREX/Testbed interoperability</b>
<b>PEO GCS (PM Stryker)</b>	<b>Phase 1: MATREX RTI, FOM, tools; Phase 2: MATREX/RDECOM/USAOTC interoperation supporting embedded training with M&amp;S wrap-around</b>
<b>PEO Soldier</b>	<b>Supporting transition to MATREX HLA and tools</b>
<b>OneSAF</b>	<b>Dross-community collaborative SAF capability development, integration into MATREX environment</b>
<b>CB Sim Suite</b>	<b>Integrate the CB Sim Suite with entity-level MATREX architecture and environment to support high-resolution CBRN analysis (SO-2 rqt and more)</b>
<b>Sensor Fusion</b>	<b>Level 1 sensor fusion algorithm integrated with Organic Communication Service in MATREX environment</b>
<b>Human Performance</b>	<b>Model the decision-making of individual combatant for Battle Command</b>
<b>Comms and Network Effects</b>	<b>Integrate SNT CES, other CES, requirements from FCS LSI and 3CE</b>
<b>Event Participation</b>	<b>JAMUS: Transition AMRDEC M&amp;S to MATREX HLA, tools,</b>